

North American skippers use *Phragmites* as a larval host, i.e., the above two and *Ochlodes yuma* (Edwards).

Note: The NRAA preserve in the Town of Porter is not open to public. Those who wish to observe the colony are welcome to contact the Association or one of the authors. The colony is small and should be protected. The NRAA has a web site (www.niagarariveranglers.com) that includes a brief description of the preserve, an aerial photograph, directions and contact information.

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LIFE HISTORY AND MYRMECOPHILY OF *NEOMYRINA NIVEA PERICULOSA* (LYCAENIDAE: THECLINAE)

Additional key words: *Crematogaster*, Dipterocarpaceae, Malaysia, *Tapinoma*, White Imperial.

The life histories of many species of Lycaenidae have been described and of these, a large percentage are commonly associated with ants (Ballmer and Pratt, 1989; Fiedler, 1991; Eastwood and Fraser, 1999; Pierce et al., 2002). While most descriptions are for temperate species, fauna from the Malaysian tropics are becoming more well-represented in the literature (Fleming, 1975; Fiedler, 1991; Corbet and Pendlebury, 1992; Fiedler et al., 1996). One species that remains poorly known though, is the White Imperial butterfly, *Neomyrina nivea periculosa* Fruhstorfer (Lycaenidae: Theclinae).

The genus *Neomyrina* Distant is represented by only a single species *nivea* with additional described subspecies (Corbet and Pendlebury, 1992). *N. nivea hiemalis* Godman and Salvin occurs in mainland Thailand and Malaysia and is considered rare (Fleming, 1975; Pinratana, 1992). *N. nivea periculosa* has been recorded from southern Burma to Thailand, throughout peninsular Malaysia including Langkawi Island, and into Sumatra. *N. nivea periculosa* is

considered more common than *N. nivea hiemalis* (Pinratana, 1992; D'Abrera, 2001). This butterfly is still typically rare, but may be locally common when encountered (Corbet and Pendlebury, 1992). *N. nivea* were observed in Thailand and central Laos by Igarashi and Fukuda (2000) and they have published aspects of the life history of the species.

Eggs and Early Instars (Fig. 1a-b). Eggs of *N. nivea periculosa* (n=7) were found in December 2002 on 2 m tall *Balanocarpus heimii* (King) (Dipterocarpaceae) trees in a shady area of the 1600-ha Forest Research Institute of Malaysia (FRIM) nursery, 15 km northwest of Kuala Lumpur in the southern peninsula of Malaysia. The eggs were deposited in small groups around the stems and leaf buds of the terminal growth. Several *Crematogaster* sp. ants (Formicidae: Myrmicinae) were observed to be in close proximity to the eggs at the time of collection and to the extrafloral nectaries of the hostplant. The eggs, plant material, and approximately 20 ants were transported to

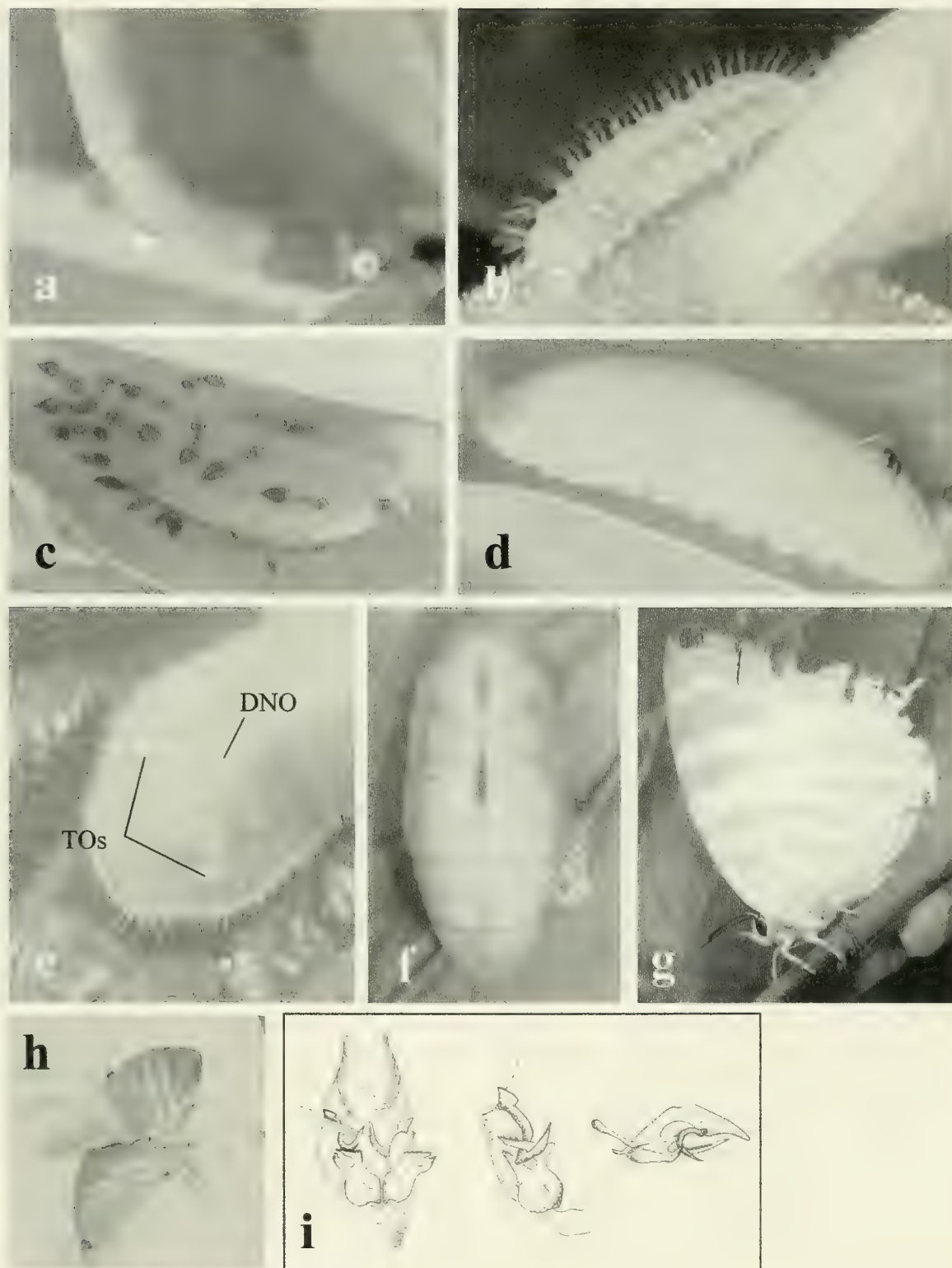


FIG. 1 Life stages of *Neomyrina nivea periculosa*; a, eggs; b, young instars; c,d, late instars tended by ants; e, late instar with everted TOs and DNO visible; f, pupa and last larval skin; g,h, adults; i, male genitalia. All photos and drawings by E.V. Saarinen.

the FRIM Entomology Laboratory and placed in a clear plastic box. Young flush from *B. heimii* was cut from the FRIM nursery trees where the eggs were initially found. The cut-ends of the plant were wrapped in wet cotton batting and placed in the plastic boxes with the eggs and ants. The eggs hatched within 24 hours and the young larvae began to feed immediately on the young leaves. All containers were cleaned daily and new host material was added.

First instar larvae were observed elevating their anterior and posterior ends simultaneously, which was followed by the attendance of *Crematogaster* sp. ants. This behavior caused ants in attendance to cease tending in one area of the larva and instead to cover the entire larva by running along the length and over the top of the young larva. Additional ants were summoned to the larva when this behavior was exhibited. After three days, all confined ants had either died or escaped when the boxes were cleaned, but second instar larvae continued the signaling behavior in their absence. Larvae did not continue feeding as much as they had when the ants were present, and no larvae lived past the second instar. Larvae were not observed building any sort of nest, as described in Igarashi and Fukuda (2000).

Eggs are white, dorso-laterally flattened, and uniformly sculpted with ridges of spikes, giving the eggs a rough exterior. Young larvae are pale yellow to pale green, onisciform, and dorso-laterally covered with fine setae that persisted in later instars.

Late instars (Fig. 1c-e). Late instar larvae (1.0-1.5 cm long) of *N. nivea periculosa* (n=6) were found on young shoots of *B. heimii* at the FRIM nursery on four separate occasions throughout October 2002. All individuals were collected with the ants that tended them and were brought to the FRIM Entomology Laboratory. On two occasions late instars were found tended by *Tapinoma* sp. ants and the larvae (n=3) were brought into the lab with the 5-10 attendant ants. In one instance *Crematogaster* sp. ants were tending a larva, and this larva (n=1) was brought into the lab with approximately 40 attendant ants. In one instance, no ants were observed with larvae in the field, and these larvae (n=2) were reared in the lab in the absence of ants. Each time larvae were collected, they were maintained in plastic boxes on young *B. heimii* leaves. All frass was removed and new host material was added on a daily basis and care was taken to keep ants in the boxes. *N. nivea periculosa* larvae exhibited a wide range of colors ranging from pale green to light red, depending on the color of leaf flush upon which they were feeding (Fig. 1d-e).

Ants, when present, congregated at the posterior ends of the larvae (Fig. 1c). Up to 30 *Crematogaster* sp.

ants were found actively and constantly attending a late instar larva. There were at least 10 *Crematogaster* sp. ants in attendance of this larva at all observed times. This behavior persisted until pupation four days later. *Tapinoma* sp. ants exhibited a very different behavior, typically observed walking around the interior of their plastic boxes. On occasion, 1-3 ants were observed tending larvae for up to ten minutes. Individual ants were observed tending larvae for 2-3 minutes at a time before wandering around the box. These larvae were left unattended for up to one hour at a time. A maximum of six *Tapinoma* sp. ants were observed tending the larvae (Fig. 1d).

Older larvae did not display the exaggerated signaling behavior observed in the first two instars. They instead have paired tentacle organs (TOs) on the dorsal surface of the 8th abdominal segment (Fig. 1e). It is unknown when these organs become active, but they are not observed in first and second instars. When these organs are extruded, additional ants are attracted to the larvae and ants already in attendance walk on and over the entirety of the larvae. The TOs are hypothesized to release semiochemicals that mimic ants' own pheromones (Henning, 1983). The TOs are also observed to act independently from one another, with only one extruded at a time in some instances. The TOs only remained everted for a few seconds before being withdrawn. Older larvae also have an active honey secreting gland, or dorsal nectary organ (DNO) on the 7th abdominal segment (Fig. 1e). Ants were observed imbibing secretions from this gland, which likely influenced the concentration of ants at the posterior end.

Pupae (Fig. 1f). Pupae are uniformly light tan in color and may exhibit a reddish tint. Final instars affix to host plant leaves and pupate within loosely assembled leaf shelters. Pupae exhibit a scar on the 7th abdominal segment in place of the DNO. Pupae are not attractive to ants 24 hours after pupation. Pupae were transferred to larger plastic boxes, 25 x 25 x 30-cm in size. Pupation lasted 11.5 days \pm 1.05 ($\mu \pm$ SD) for all pupae (n=6).

Adults (Fig. 1g-h). A total of four adults successfully emerged, resulting in an even sex ratio (2M:2F). As larvae were field collected at different times, it is unknown which sex typically emerges first. Of the three individuals that pupated at the same time, a male eclosed first. This male was observed to stay in close proximity to the two female pupae. He was observed alighting on the pupae and flapping his wings continuously upon contact with the pupae. Once all the adults had emerged, attempts to induce copulation were carried out by shining a light on the plastic box with butterflies for six hours a day for four days. A cotton ball

with a 50% sugar solution was given as a nutrient source and was replaced daily. There were also sprigs of cut host plant in small plastic water bottles placed in the box with the butterflies. All butterflies were observed feeding from the sugar ball but no captive mating was observed despite the light and heat stimulation. Adults lived for 6–19 days in captivity. Following death, the genitalia of the first eclosed male was dissected (Fig. 1i). Only one tattered adult female was ever observed in the field (Fig. 1g).

This report indicates evidence of a facultative symbiotic relationship between the larvae of *N. nivea periculosa* and ants of two genera, *Tapinoma* and *Crematogaster*. Igarashi and Fukuda (2000) also found larvae in Thailand tended by *Lasius* sp. The relationship with ants is clearly unspecific and facultative as now three genera, each belonging to a different subfamily of ants, have been found associating with *N. nivea* larvae to varying degrees of intimacy. The relationship is deemed facultative as larvae were able to pupate and adults successfully eclose in the absence of ants. The ant genera associating with *N. nivea* are very typical ant associates of lycaenid larvae (Eastwood and Fraser, 1999). This loose association supports the idea that non-specific, facultative relationships prevail among Southeast Asian lycaenids (Fiedler, 1997).

Of the three larvae that were maintained with *Tapinoma* sp. ants, only one adult (male) resulted. One larva was maintained with *Crematogaster* sp. ants, and the adult (female) successfully eclosed. The two larvae collected and maintained in the absence of ants successfully eclosed as a small adult male and a normal-sized female. In the plastic boxes, *Crematogaster* sp. ants were always found tending their larva, while *Tapinoma* sp. ants left their larvae unattended while they walked around the interior of the box. Igarashi and Fukuda (2000) noted that *Lasius* sp. were sometimes found with a larva in such great numbers as to hide the larva from view. This indicates that *Crematogaster* sp. and *Lasius* sp. ants would be more effective at protecting larvae from predators and parasitoids in the field than *Tapinoma* sp.

Balanocarpus heimii (Dipterocarpaceae) a resinous, timber tree found in Southeast Asia is noted as a host plant for *N. nivea periculosa*. In Thailand, larvae were observed feeding on *Kurrimia paniculata* (Celastraceae) and were observed ovipositing on *Fissistigma wallichii* (Annonaceae) in Laos (Igarashi and Fukuda, 2000). These host plant records are of importance as they demonstrate *N. nivea* feeding on at least two different and unrelated plant families. It is additionally important as most lycaenid larvae feed on plants in the family Leguminosae or members of the subclass Rosidae. It

should be noted that representatives of the Theclini show a more diverse host plant preference and that polyphagy is pronounced in Southeast Asian lycaenids as a whole (Fiedler, 1995; 1997).

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